RHIC SYSTEMS

Power Supplies, Superconducting Magnets, Quench Protection, etc.

6/16/05

Work Done Before and During Run 5
Power Supplies

Corrector Power Supplies

- All 620 removed and modified
- Trips to ERROR state fixed
- Setpoint filter added
- Improved the 2.5V reference which is used for OT, DCOC and Quench Faults.
- Tightened all AC connections
- Tightened all DC connections at CQS magnet trees
- Installed voltage monitoring boards in sector 1

Work Done Before Run 5
Power Supplies

IR power supplies

- All 150A and 300A bipolar units removed and glyptol was applied to converter board 208VAC connections.
- All Dynapower units had a relay added to eliminate the error fault which occurred at turn on. NONE IN RUN 5.
- All rack mounted dynapower units had glyptol applied to housekeeping p.s. 208Vac connections.
- Added MOV's to ac inputs of dynapower rack mounted units

Sextupole P.S.'s

- Installed SCR monitoring circuit for magnet crowbar SCR's

Work Done Before Run 5
Power Supplies

Main Power Supplies

- Tightened all connections
- Installed monitoring of main SCR's in Output Circuit compartment .
- Removed main SCR's in output circuit compartment, cleaned, inspected and re-installed.
- QLI's due to mains went from 46 to 5

Work Done During Run 5
Power Supply Software Modifications

- Started using Automatic QLI program
- TAPE modified to wait until qdRealQuench pet page saves data
- Voltage Monitoring testing software written and tested.

Work Done Before and During Run 5
SC Magnets

- Yellow sector 10 D6 shunt bus to ground short. The bus was isolated from rest of magnet circuit.
- Yellow sector 12 Q7 shunt bus to Q9 shunt bus short. The buses were repaired.
- Blue sector 12 Q6 shunt bus has an 83 $\mu\Omega$ resistance when powered to 120 A during the proton 205 GeV test. Will add one additional voltage tap during the summer shut down to try to locate the high resistance to a smaller group of magnets when we get cold in the fall.
- Hi-Pots and Cleaning of magnet trees. Rework sextupole ceramic lead tefzel insulation to prevent low resistance to ground problems.

Work Done Before Run 5
Quench Protection

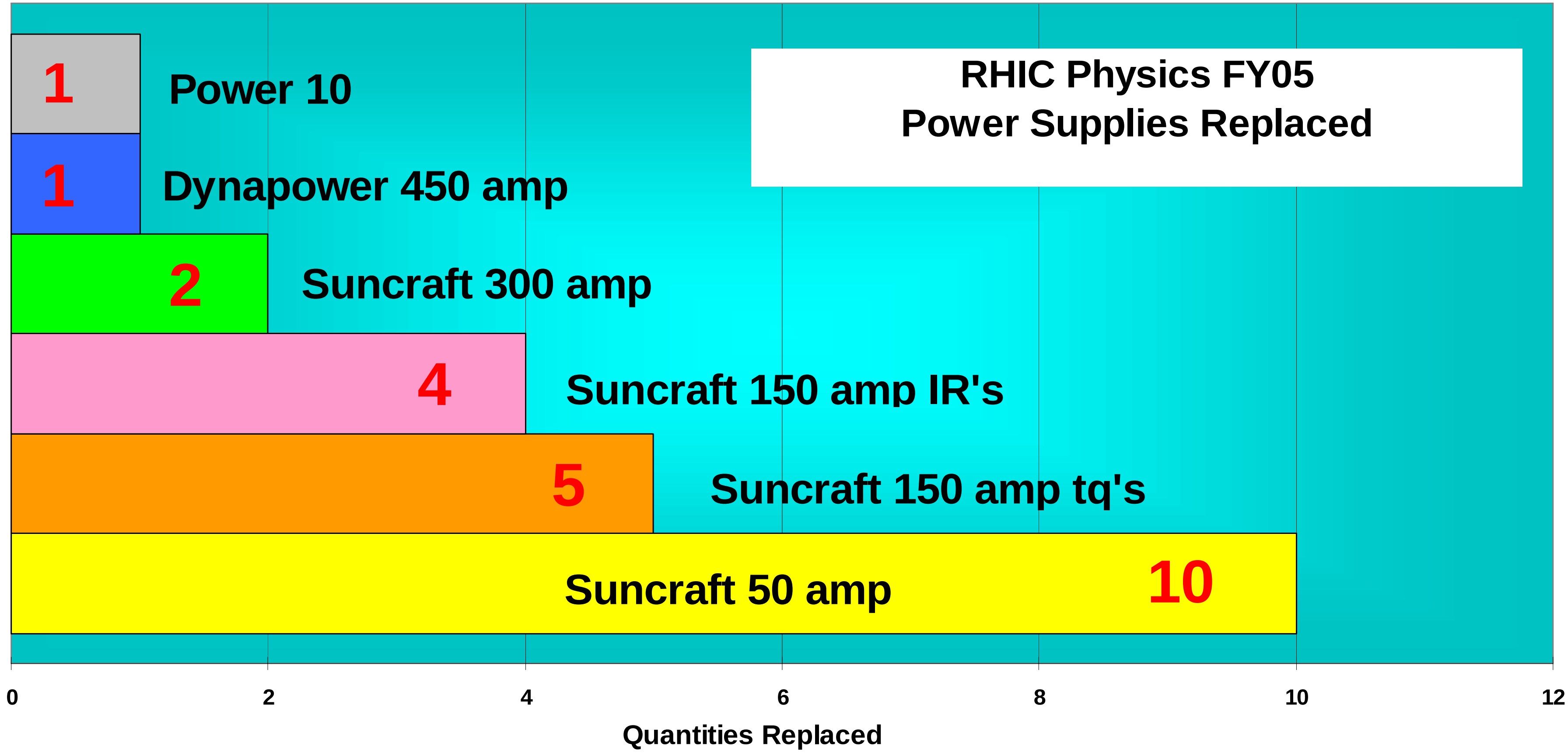
- **Quench Detector Hardware –** Cleaned air filters.
- **Quench Detection Tuning-** Improved inductance tables to allow even faster ramps from park to injection, top energy to injection, and injection to park for Cu run.
- **Quench Detection Software-** Latest software that has the correct alarm time stamps was installed and tested.

Work Done Before and During Run 5
“Ice Balls”

- New heaters and thermostats installed on triplets magnet trees.
- New heaters and thermostats installed on valve box leads.
- Temperatures from the “Ice Ball “ monitor made part of alarm system.
- Time delay added to alarm function to minimize false alarms.

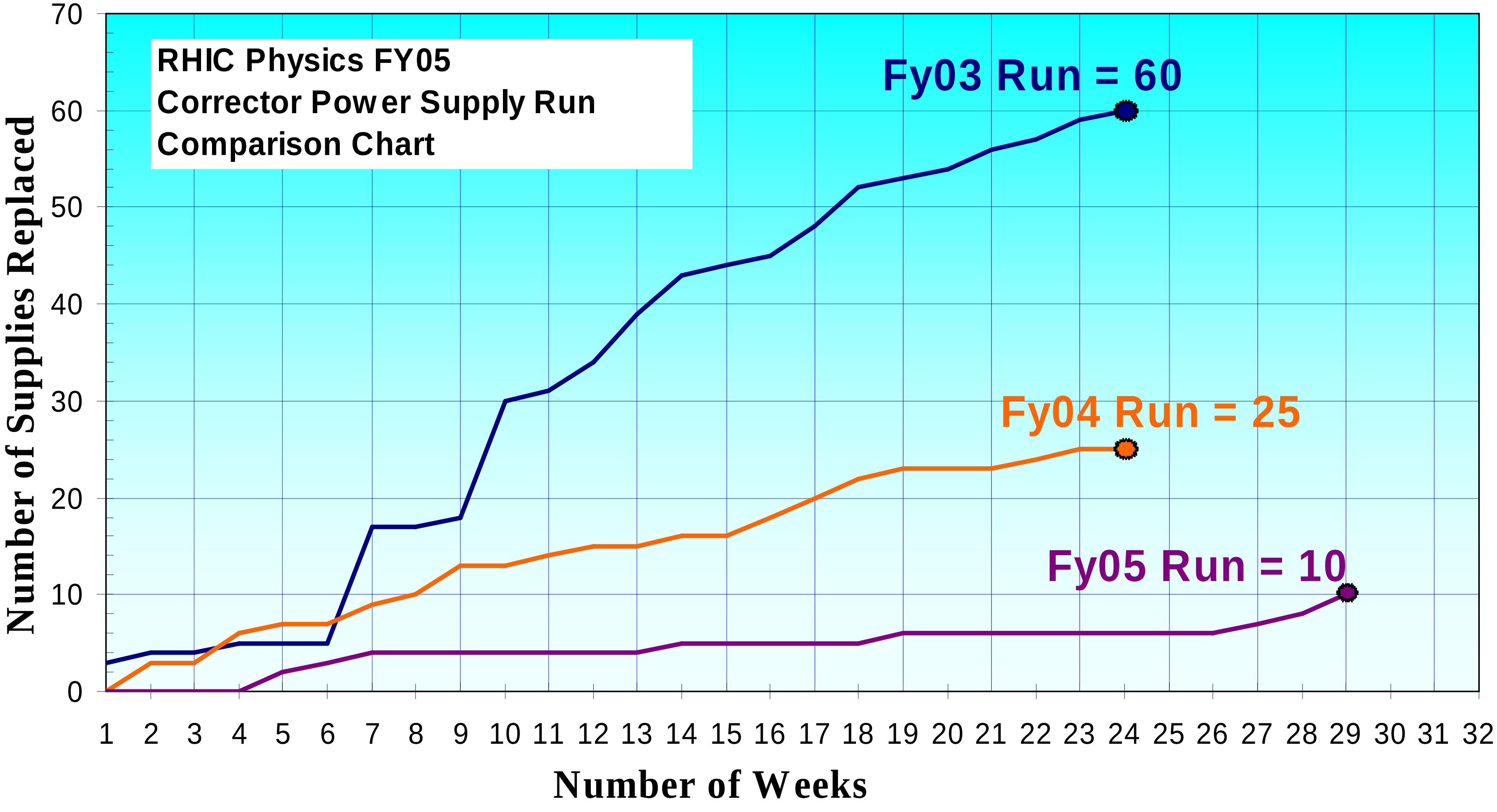
AGS Cold Snake

- Power supplies, quench protection, quench detection, and controls were all assembled and used in bldg. 902 vertical and horizontal magnet tests.
- The software was the final version for the horizontal magnet test in bldg. 902.
- Horizontal test showed cryo-coolers were able to maintain helium level constant with the magnet powered to full current in all circuits.
- Major problem was the helium pressure rise after a helical magnet quench. The pressure relief configuration had to change in the horizontal 902 test and the AGS installation.
- Electrical installation in the AGS took a few days and we were ready to power the magnet one day after the installation period.



RHIC Physics FY05
Power Supplies Replaced
1
Power 10
1
Dynapower 450 amp
2
Suncraft 300 amp
4
Suncraft 150 amp IR's
5
Suncraft 150 amp tq's
Suncraft 50 amp
10
0
2
4
6
8
10
12
Quantities Replaced

Power Supply and other Systems Performance for Run 5



Corrector PS problems in Run 5

- 3 tripped on OT's because of shorted bypass caps
- 1 failed on error fault, found failed buffer chip.
- 1 tripped irefCurrent range error, found failed chip on dcct card and loose screw on dcct bus.
- 1 tripped Off, nothing found on bench.
- 1 tripped on an error fault, nothing found on bench
- 1 removed for investigation of blip, not for failure
- 1 removed for OverVoltage Fault, investigating.
- 1 removed for Error & DCOC fault, investigating.
- **Summary: 5 explained hardware failures. 2 not reproduced on the bench. Investigating 3 others still.**

Power Supply and other Systems Performance for Run 5
IR Power Supplies

	Run 3	Run 4	Run 5
SCE 150's	14	2	9
SCE 300's	6	1	2
Dynapower	2	1	1
Dyn Aux Contacts	10	19	0

SCE Bipolar 300A IR PS Problems During Run 5

- 1-300A failed on error flt, found 2 blown MOSFETS on H-Bridge output which caused other failures in this P.S.
- 1-300A failed possibly due to a cooling problem, still investigating.

SCE Bipolar 150A & Dynapower PS Problems

During Run 5

SCE 150A Power Supplies

- 1-hardware failure - open resistor in soft start circuit
- 4-not reproducible on the bench-1 had multiple faults, 1-error, 1-CB trip, 1-DCOC. Still will be looked at.
- 2-still investigating (cable inside, AC phase flt)
- 1-good, cable outside was the problem.
- 1-being investigated.

Dynapower Power Supplies

- 1- Dynapower had a loose 120Vac connection on a gate drive card-tripped link 9 times.

Quench Detector Problems

3 Hardware Problems that caused 14 Trips

- Single Gain Mux Card –Temperature Channel, 5 trips, 1 card
- Fan Fail Card, 7 trips, 1 card
- Loose Voltage Taps wire, 2 trips, 1 wire

2 Software Problems that caused 6 Trips

- FECs that needed reboots, 5 trips
- DSP that needed to be restarted, 1 trip

Other problems

- Cable between p.s and QPA’s or QPA’s and QPAIC-unexplained trips. These unexplained trips totaled about 8 trips on 3 separate p.s.’s.
- 12 qpa faults, 8 fan switches, 3 fans, and 1 OVC.
- Buffer cards- 2 cards with shorted bypass caps
- Current reg card relays – 6 cards found with bad relays
- Two IR p.s.’s had OFF trip problems that tripped the links about 4 times.

Power Supply and other Systems Performance for Run 5
QLI Counters

QLI Counters for 2004-2005 Run

Beam Induced	36	Quench Detector Faults	19
IR Supply Faults	51	QPA Faults	6
Main PS Faults	6	Snake & Spin Rotator	Detail
Controls 6B Yell. Permit	0	Controls Related	13
Operations Error	12	Cryo Related	4
Power Failure	7	Other	29
Maintenance Related	20	Power Supply Induced	0
		Total	203

As of 06/14/05 09:55:56

Power Supply and other Systems Performance for Run 5
RHIC Helical Magnet System Trip Counters

2004 -2005 Snake & Spin QLI Counters			
Beam Induced	2	Quench Detector Faults	0
Power Supply Faults	0	QPA Faults	0
Operations Error	0	Cryo Related	3
Power Failure	2	Other	5
Maintenance Related	0	Total	12

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Power Supply and other Systems Performance for Run 5
Run to Run Comparison

The next slide contains the QLI counters for the last 4 runs so they can be compared. The run listed as FY02 is not a complete set of data. We started keeping track of some of the data in August of 2001 and some other data in September of 2001 and some other data on October of 2001. The FY05 data is the same as the QLI counters shown in the previous slides called Run 2004-2005.

Power Supply and other Systems Performance for Run 5
Run to Run Comparison

Main QLI Faults		Run 2	Run 3	Run 4	Run 5
Beam Induced		46	69	54	**36**
Quench Detector Faults		13	29	13	**19**
IR Supply Faults		100	44	24	**51**
QPA Faults		40	6	9	**6**
Main PS (Total) Faults		68	38	46	**6**
Controls 6B Yellow Permit Fail		25	9	24	**0**
Controls Related		20	15	20	**13**
Operations Error		34	15	17	**12**
Cryo Related		6	9	2	**4**
Power Failure		10	8	3	**7**
Other		27	27	24	**29**
Power Supply Induced Quench		6	1	4	**0**
Maintenance Related		8	34	83	**20**
(Sub Totals)	*1233*	*403*	*304*	*323*	*203*
Total minus Maintenance:	**1088**	**395**	**270**	**240**	**183**

Power Supply and other Systems Performance for Run 5
Run to Run Comparison

Snake / Spin Quench Faults		Run 2	Run 3	Run 4	Run 5
Beam Induced		20	17	5	**2**
Quench Detector Faults		0	0	1	**0**
Power Supply Faults		10	2	4	**0**
QPA Faults		0	0	0	**0**
Operations Error		2	0	2	**0**
Cryo Related		2	0	1	**3**
Power Failure		0	0	2	**2**
Other		2	6	0	**5**
Maintenance Related		0	0	0	**0**
(Sub Totals)	***88***	***36***	***25***	***15***	***12***
Total minus Maintenance:	**88**	**36**	**25**	**15**	**12**

Work Planed for Summer 05

IR and Corrector Power Supplies

- Checking all Dynapower p.s.'s for loose wires on gate drive cards and all other wires will be checked that are in this open area.
- Inspecting all D connector cables between qpa and p.s.'s, as well as between qpa and qpaic to fix unexplained trips. Those that have had these unexplained trips will have cables completely replaced. We will also check hardware on chassis ends.
- Checking all current regulator card relays again with tap test.

Work Planed for Summer 05

IR and Corrector Power Supplies – cont’d

- Check ac connections on Dyn CB’s & Contactors
- Install fan interlock test points on qpa’s
- Check all insulation displacement connectors on QPA’s that tripped on an OVC fault.
- Inspect problems fixed but never resolved such as OFF trips on 2 IR p.s.’s, y2-dh0 setpoint drift not understood.
- Test writing to node card ports individually
- Remove 16 correctors that need DCCT Head pins cleaned.

Main Power Supplies Work Summer 05

- Adding instrumentation to monitor gate current of OCC Quench SCRs. This will detect an abnormal condition and report to the control system.
- Maintenance on all Phoenix style connector connections.
- Other maintenance items.
- Software changes (autocal at 50A problem and quench diagnostics in regulator)

Work Planed for Summer 05

Quench Detector Hardware - Simple mechanical maintenance. Replace temporary connection to the helical magnet voltage taps with the permanent design.

Quench Detector Server - During shutdown the quench detectors may go on their own network. All qd's rebooted one day. Could be due to network traffic.

Quench Detection Software – No new work planned

Quench Detection Tuning –Data taken for improving tq tuning past 30A, is it required for next years run?

Quench Protection Switches – Perform maintenance on all 6 KAmp mechanical interrupter and tighten all connections.

Work Planed for Summer 05

“ ICE BALL” Prevention

- Have had 3 GFI trips at triplet magnets because of the way the thermostat is mounted. This will be fixed. We will also install 1 ground fault relay that can be reset remotely. If this works out we may replace all GFI circuit breakers with the ground fault relay.
- Improvements to heaters and thermostats installed on valve box leads.

Work Planed for Summer 05

Corrector Lead Voltage Monitor System

- Finish Installing new 1-Wire voltage monitor boards at each CQS and triplet corrector lead.
- There will be 492 boards.
- Each board can monitor 4 signals.
- The system monitors the total voltage across a magnet circuit right at the room temp. end of the gas cooled leads.
- When the magnet current is DC (Not ramping) the voltage measured is then the lead voltage.
- This system will allow, for the first time, a way to measure the performance of these gas cooled leads. This can lead to operational flexibility when there is a low flow condition.
- The final goal for this system is to develop a corrector lead interlock system that is independent of the cryo lead flow .

Work Planed for Summer 05

New Software and Software Modifications

- Need more data from the cryo system to be available remotely and for it to be logged. (Corrector lead flows)
- UPS monitoring that will have alarms and give correct direction to operations when AC power is lost on critical systems.
- Voltage monitoring production software to be written and tested.
- Continued improvement of automatic qli analysis program
- Improvements to snapshot selector window
- A program to check for ps errors during beam abort and enter it into e-log automatically.
- Add mains to snapshot.
- TAPE should check if links are up before running

RHIC PS Performance Numbers

Average RHIC PS Failure Hours/Week (Peter Ingrassia)

fy01-fy02	fy03	fy04	fy05
18.28	4.36	3.29	2.4

MTBF of RHIC due to any PS Failure

	RHIC Run 4	RHIC Run 5	HERA e+p 1996
MTBF_M (hours)	20.48	29.82	22.3
Number of Problems	148	130	238

What would be the %AV of RHIC be if only RHIC ps Failures?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996
AV%	91.97	96.9	96.6
Number of Problems	148	130	238

MTBF of an individual PS Failure

	RHIC Run 4	RHIC Run 5	HERA e+p 1996
MTBF(hours)	19106.33	27823.85	29310
Number of PS's	933	933	1166

END

MTBF DETAILS IF NEEDED

What is the average time RHIC can run before experiencing any PS Failure?

$$\text{MTBF\_M RHIC} = \frac{\text{MT}}{\text{NOF}}$$

	RHIC Run 4	RHIC Run 5
MTBF_M (hours)	20.48	29.82
Number of Problems	148	130

The bigger the MTBF_M number is, the better we are doing.

How does this MTBF_M compare with other labs machines?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996	Doris 1996	Entire DESY
MTBF_M (hours)	20.48	29.82	22.3	61	9.2
Number of Problems	148	130	238	87	574

If you ignore all other failures in the machine, except for ps failures, what would be the %Availability of the RHIC machine.?

$$AV\% = \left(\frac{[MT - (NOF \times TOR)]}{MT} \right) \times 100$$

	RHIC Run 4	RHIC Run 5
AV%	91.97	96.9
Number of Problems	148	130

How does this %AV compare with other labs?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996	Petra 1996	Entire DESY
AV%	91.97	96.9	96.6	98.7	91.9
Number of Problems	148	130	238	87	574

What is the average time an individual P.S. can run before experiencing a Failure?

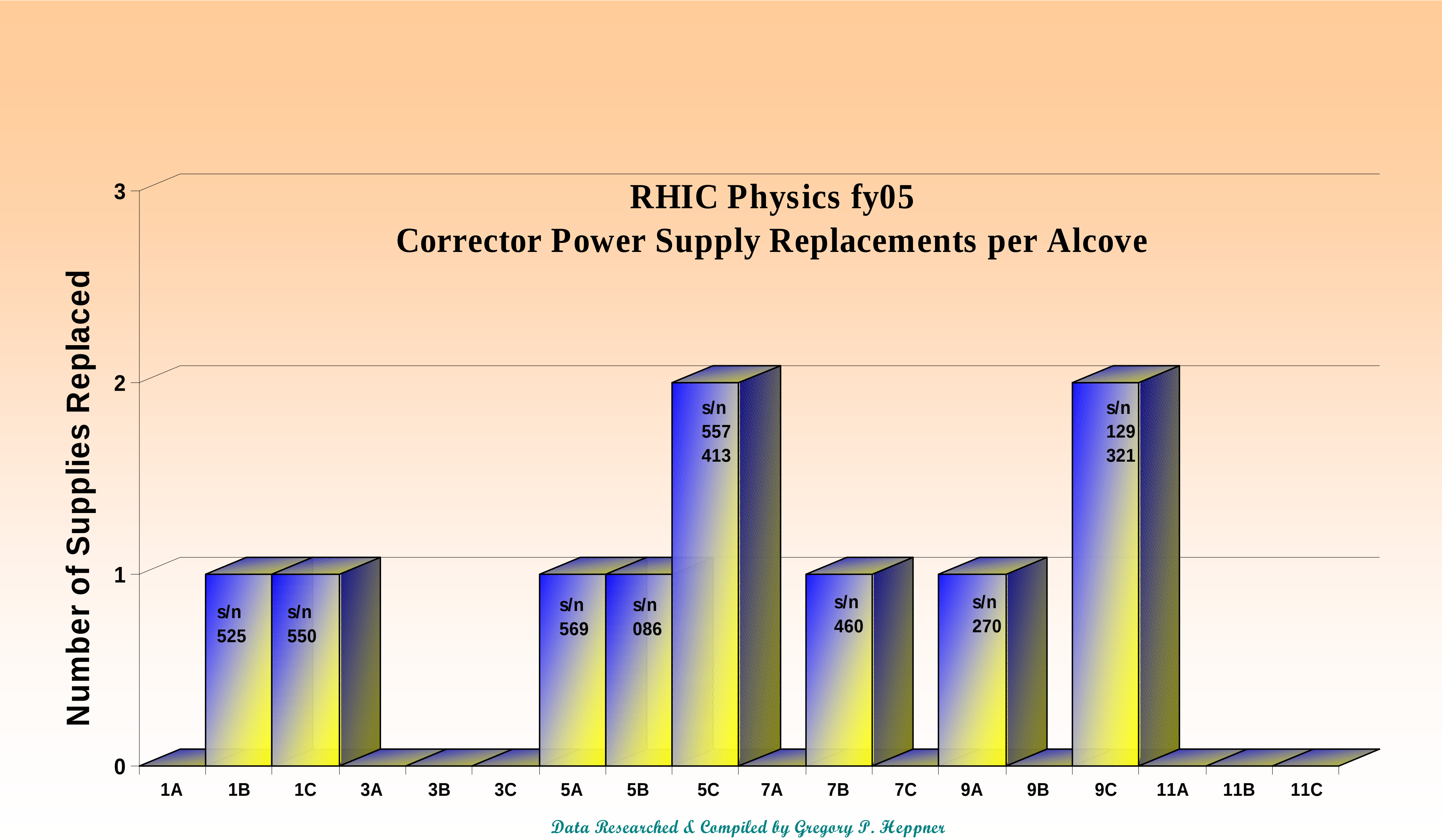
$$\text{MTBF\_Power Supply Systems} = \left(\frac{(\text{MT x NOPS})}{\text{NOF}} \right)$$

	RHIC Run 4	RHIC Run 5
MTBF(hours)	19106.33	27823.85
Number of PS's	933	933

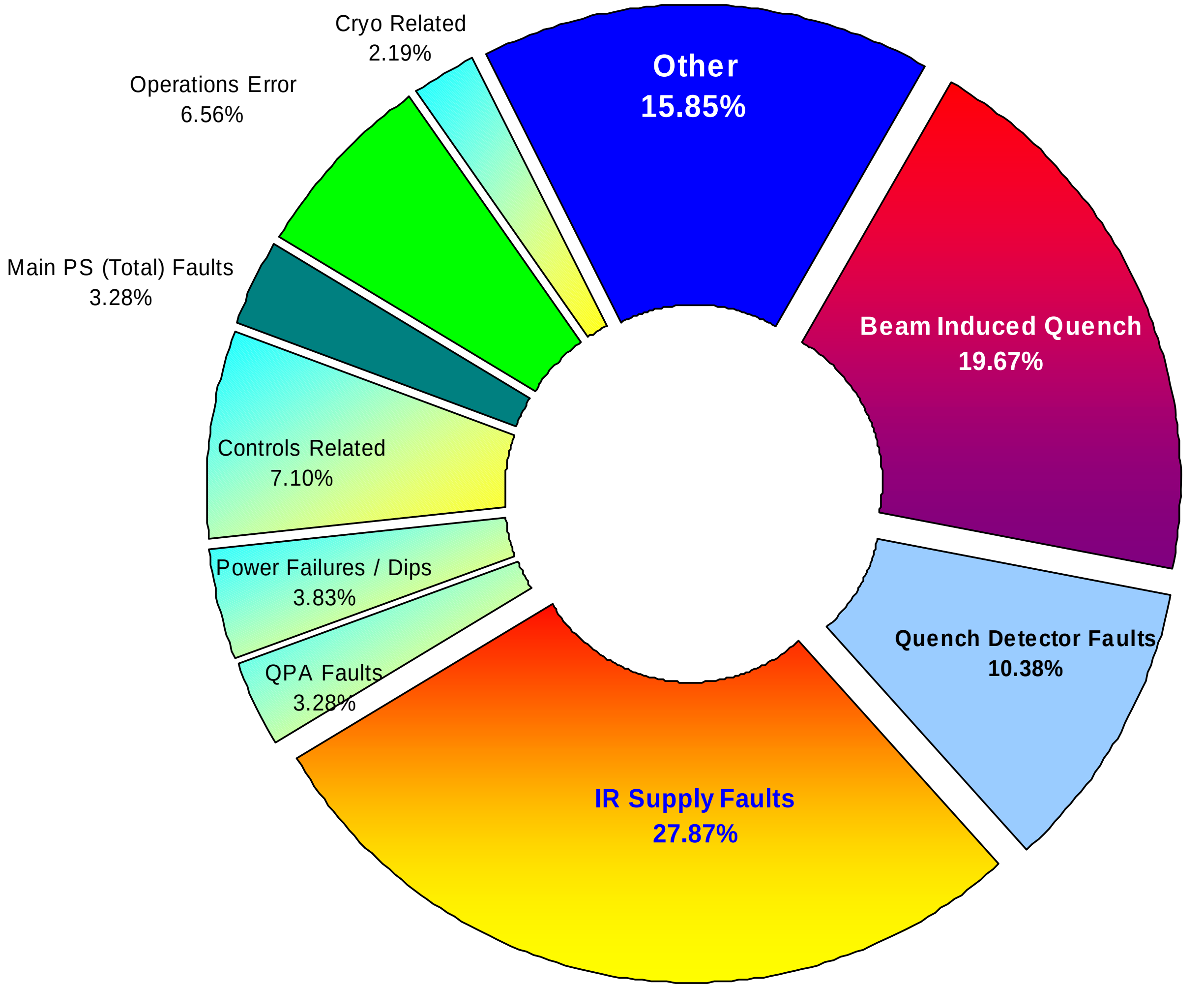
How does this MTBF_PS SYSTEMS compare with other labs?

	RHIC Run 4	RHIC Run 5	HERA e+p 1996	Doris 1996	Petra 1996
MTBF(hours)	19106.33	27823.85	29310	8968	13988
Number of PS's	933	933	1166	93	269

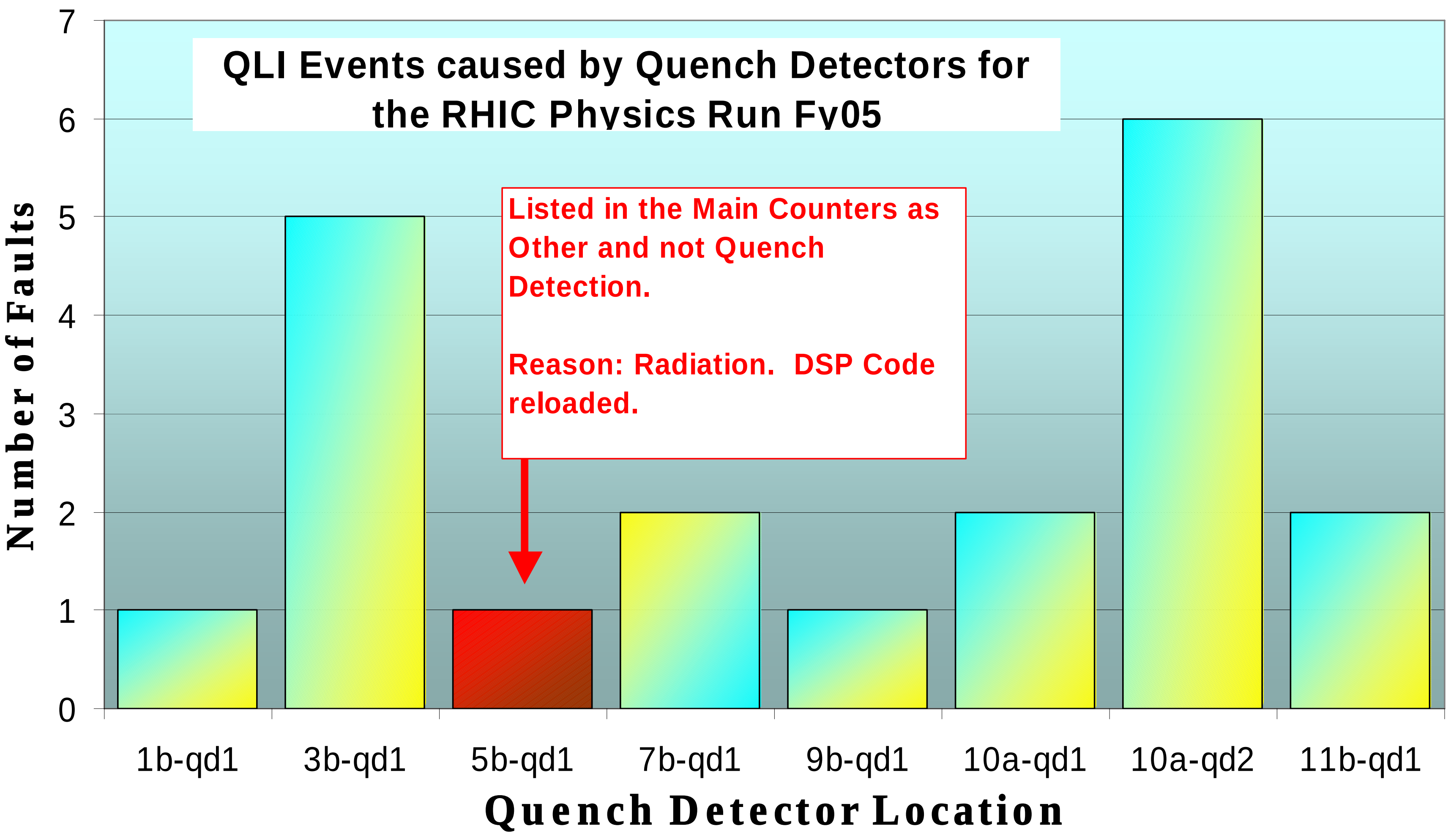
Charts



RHIC Physics fy05
Corrector Power Supply Replacements per Alcove
Number of Supplies Replaced
0
1
2
3
s/n 525
s/n 550
s/n 569
s/n 086
s/n 557 413
s/n 460
s/n 270
s/n 129 321
1A
1B
1C
3A
3B
3C
5A
5B
5C
7A
7B
7C
9A
9B
9C
11A
11B
11C
Data Researched & Compiled by Gregory P. Heppner



Cryo Related
2.19%
Operations Error
6.56%
Other
15.85%
Main PS (Total) Faults
3.28%
Beam Induced Quench
19.67%
Controls Related
7.10%
Power Failures / Dips
3.83%
Quench Detector Faults
10.38%
QPA Faults
3.28%
IR Supply Faults
27.87%


QLI Events caused by Quench Detectors for the RHIC Physics Run Fy05
Listed in the Main Counters as Other and not Quench Detection.
Reason: Radiation. DSP Code reloaded.
Number of Faults
0
1
2
3
4
5
6
7
1b-qd1
3b-qd1
5b-qd1
7b-qd1
9b-qd1
10a-qd1
10a-qd2
11b-qd1
Quench Detector Location